REMARKS/ARGUMENTS

Claims 1, 4-6, 11, 13 and 14 are pending herein. Claim 1 has been amended as supported by page 3, lines 14-15 of the specification, for example. Claims 2, 3, 8-10 and 12 have been cancelled without prejudice or disclaimer. New claim 13 has been added as supported by Fig. 1, page 6, lines 1-3, and page 6, lines 18-21 of the specification, for example. New claim 14 has been added as supported by page 7, lines 20-23 of the present specification, for example. Applicants respectfully submit that no new matter has been added.

Examiner Kornakov is thanked for courtesies extended during a telephonic interview on October 12, 2010, during which time he indicated that the addition of new claims after final rejection would raise new issues and thus would not be entered. Accordingly, an RCE is filed herewith.

1. The rejection of claims 2 and 8 under §112, second paragraph is noted, but deemed moot in view of the cancellation of claims 2 and 8.

2. Claims 11-12 were rejected under §112, first paragraph. The rejection is noted, but overcome by the reasons explained below and by the cancellation of claim 12.

Claim 11 recites that the gallium nitride single crystal is grown at a rate of at least 25 μm/hr. This growth rate was achieved in Example 2 as a result of the same experimental conditions used in Example 1, except for the use of an applied total atmospheric pressure of 300 atms with nitrogen making up 120 atms of that pressure

(see page 8, lines 1-6 of the specification). The growth process of Example 2 used a seed crystal (i.e., AlN template) having a diameter of 2 inches, which was immersed in the flux and held in that position for 100 hours (see page 7, lines 22-23 of the specification). The resulting grown GaN single crystal of Example 2 had a thickness of 2.5 mm (i.e., 2,500 μm) with a diameter of 2 inches upon removal from the flux after 100 hours. As such, the gallium nitride single crystal of Example 2 was grown at a rate of at least 25 μm/hr (2500 μm ÷ 100 hrs), as recited in pending claim 11. The growth rates achieved in Examples 1, 4 and 5 are even higher.

Applicants respectfully submit that the foregoing explanation clearly addresses and clarifies all support informalities asserted by the Examiner on page 3 of the Office Action mailed July 22, 2010. Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the §112 rejection of claim 11.

3. Claims 1-4 were rejected under §102(e) over Sasaki (US 2006/0051942). The rejection of claims 2 and 3 is noted, but deemed moot in view of the cancellation of those claims. To the extent that this rejection may be applied against amended claim 1 and dependent claim 4, it is respectfully traversed.

Amended claim 1 recites a method of growing a gallium nitride single crystal using a flux with at least a sodium metal, and comprises the steps of growing the gallium nitride single crystal in an atmosphere having a total gas pressure of 300 atms to 1200 atms at a temperature within the range of 900°C to 1200°C. The pressure of nitrogen gas in the atmosphere is 120 atms to 600 atms.

Based on the Examiner's comment on page 11 of the Office Action, it appears that some clarifying remarks are in order concerning the gas pressure ranges recited in claim 1. Amended claim 1 recites that the atmosphere contains at least nitrogen gas and has a total pressure of 300 atms to 1200 atms, with the nitrogen gas pressure being between 120 atms to 600 atms. Therefore, if the atmosphere contains only nitrogen, the total pressure of the atmosphere would be 300 atms. If the atmosphere contains another gas in addition to nitrogen, the amount of nitrogen would be at least 120 atms, in which case the other gas in the atmosphere would make up at least 180 atms (to meet the 300 atms total pressure minimum).

As explained in detail in the Amendment and Rule 132 Declaration filed June 22, 2010, the present invention defies conventional wisdom in the art of sodium metal flux crystal growth by performing the method at a substantially higher total atmospheric pressure of 300 atms to 1200 atms (of which 120 atms to 600 atms must be nitrogen) and the now claimed substantially higher temperature range of 900°C to 1200°C. The higher pressures and temperatures used in the presently claimed method unexpectedly provide a single gallium nitride single crystal growth rate that is at least 25 μm/hr (again, please see Examples 1, 2, 4 and 5 described from page 7, line 22 – page 9, line 2 of the present specification). Such high growth rates have heretofore not been available in the art of sodium metal flux crystal growth.

The criticality of the presently claimed pressure and temperature range combination is evidenced by Example 3 and Comparative Example 1 in the present specification. In Example 3, the inventors used the same pressure range limits and

procedure as in Example 1 (and subsequently in Example 2) except for applying a growth temperature of 850°C, which is just modestly below the temperature range of 900°C to 1200°C now recited in pending claim 1. This seemingly modest reduction and variation in the growth temperature of Example 3 (while still applying atmospheric gas pressures within the claimed pressure limits) surprisingly resulted in many individual and/or separate multiple GaN single crystals being grown on the seed crystal, as opposed to the single, large GaN single crystal that was intended (see Example 3 results on page 8, lines 9-14 of the present specification as compared to the results of Examples 1 and 2 described above, and also as compared to Examples 4 and 5, which confirm the criticality of the presently claimed pressure and temperature ranges).

Additionally, Applicants respectfully submit that the experiment of Comparative Example 1 was performed, again within the procedural limits of Example 1 except for a modest reduction in gas pressure to only slightly below the specified and claimed pressure limits of the present invention. Again, with only this modest reduction in the amount of atmospheric pressure and nitrogen content applied to the seed crystal, it was discovered that the seed crystal remained molten, and as such, no GaN single crystal was obtained or grown (see the results of Comparative Example 1 on page 9, lines 4-8 of the specification).

Applicants respectfully submit that the presently claimed method of growing a gallium nitride single crystal efficiently provides a significantly improved GaN single crystal growth rate for forming a single, large gallium nitride single crystal with

improved size, clarity, quality and yield, while further reducing the overall time needed to the single crystal, without the concern or fear for any multiple crystal growth and/or quality defects that conventional GaN prior art crystal growth methods previously experienced.

In addition, Applicants respectfully submit that the Rule 132 Declaration of Mr. Makoto Awai (filed June 22, 2010) provides even further evidence that the presently claimed method of growing a gallium nitride single crystal defies all previous conventional wisdom associated with sodium metal flux techniques that traditionally used relatively low atmospheric pressures and growth temperatures during the implementation of these prior art growth methods and techniques (see Sections 4-8 of the Declaration).

Applicants respectfully submit that the Declaration evidence clearly supports Applicants' contention with respect to a GaN nitride single growth method within a specifically claimed higher atmospheric pressure range of 300 atms to 1200 atms, with the atmosphere having a nitrogen pressure of 120 atms to 600 atms while fully supporting the higher and now claimed narrower temperature range of 900°C to 1200°C. Therefore, Applicants respectfully submit that the Declaration provides further indisputable evidence (in addition to Examples 1, 2, 4 and 5 contained in the original specification) that clearly show single gallium nitride single crystal growth rates of 25 μm/hr to 50 μm/hr, which is a three to six fold improvement over the applied prior art of record.

Neither the claimed invention nor the attendant advantages thereof would have been disclosed or obvious to one skilled in the art based on Sasaki.

Sasaki discloses a method for producing a group III nitride single crystal which reacts from at least one group III element selected from a group consisting of gallium, aluminum and indium, with nitrogen in a mixed flux of sodium and at least one of an alkali metal and an alkaline earth metal (see Abstract of Sasaki). Applicants respectfully submit that Sasaki merely discloses an excessively wide and open temperature range of 300°C to 1500°C and an even wider pressure range of 100 Pa to 200 MPa (0.00099 atms – 1974 atms) as conditions for producing the gallium nitride single crystal or other group III element nitrides as well (see paragraphs [0027] and [0029] of Sasaki). There is no enabling disclosure in Sasaki*, in any manner or form, regarding the use of the very specific range of atmospheric pressure (or any mention of the inclusive and additionally specific nitrogen gas pressure range necessary) nor the presently claimed and narrow temperature range now recited in pending claim 1 required to obtain and grow a single GaN single nitride crystal at a growth rate of 25 μm/hr or greater, as in the present invention. Indeed, the Examples in the present specification as discussed above prove that the majority of the temperature and pressure ranges disclosed in Sasaki would not achieve the growth rate recited in pending claim 11.

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* A reference applied under §102 must enable the claimed invention that it allegedly anticipates ("A rejection for anticipation under Section 102 requires that each and every limitation of the claimed invention be disclosed in a single prior art reference. [citing *In re Spada*, 911 F.2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990)]. In addition, the reference must be enabling and describe the applicant's claimed invention sufficiently to have placed it in possession of a person of ordinary skill in the field of the invention." *In re Paulsen*, 31 USPQ2d 1671, 1673 (Fed. Cir. 1994)).

Additionally, the actual application and growth process that is enabled by the disclosure of Sasaki is carried out in all instances at an atmospheric and/or nitrogen pressure of 50 atms or less, and as such, significantly lower in both pressure and temperature than the specific ranges recited in pending claim 1 (see Examples 1-13 described in paragraphs [0054]-[0085] of Sasaki). Further, Applicants respectfully submit that the largest obtained GaN crystal grown in Sasaki over a 96 hour period was 800 μm, which merely equates to a growth rate of 8.3 μm/hr, which is by comparison significantly smaller in overall size and rate than that of the present invention (see Example 7, paragraph [0077] of Sasaki).

In light of the foregoing, Applicants respectfully submit that it is clear that there is no disclosure or suggestion in Sasaki of the specifically claimed high atmospheric pressure range and temperature to provide an accelerated growth rate and consistently large single gallium nitride single crystals grown from a seed crystal, where the overall size, quality and yield achieved is greatly improved, as in the case of the presently claimed invention. As such, Applicants respectfully submit that there is no disclosure or suggestion in Sasaki regarding the very specific atmosphere pressure range, including the specifically necessary and inclusive pressure range amount of nitrogen gas (of the total atmospheric pressure) that is heated within a temperature range of 900°C to 1200°C for growing a gallium nitride single crystal, as presently claimed.

Applicants respectfully submit that Sasaki fails to disclose or suggest each and every element recited in amended claim 1. Accordingly, Applicants respectfully submit that claim 1 and claim 4 depending therefrom, define patentable subject matter

over the applied reference, and respectfully request that the above rejection be reconsidered and withdrawn.

4. Claim 5 was rejected under §103(a) over Sasaki in view of Sarayama (US 2002/0175338); claim 6 was rejected under §103(a) over Sasaki in view of D'Evelyn (US 2006/0096521); and claim 11 was rejected under §103(a) over Sasaki in view of Kitaoka (US 2004/0144300). Applicants respectfully submit that the arguments submitted above distinguish amended claim 1 from Sasaki. Since Sarayama, D'Evelyn and Kitaoka fail to overcome the deficiencies of Sasaki, and since claims 5, 6 and 11 depend directly from claim 1, these claims are also believed to be allowable over the applied prior art.

In addition, and with regard to the rejection of claim 11, Applicants respectfully submit that Kitaoka merely discloses a method of manufacturing a group III nitride substrate that has multiple single crystals on an underlying substrate at a rate of growth reportedly between 20 μm/hr to 50 μm/hr (see Fig. 1C and paragraph [0038] of Kitaoka). Although Kitaoka may disclose high growth rates of multiple group III nitride crystals, there is no disclosure or suggestion in Kitaoka regarding the use of the very specific pressure and temperature ranges recited in pending claim 1, to ensure the accelerated growth rate of a single gallium nitride single crystal, as in the case of the presently claimed invention.

Further, Applicants respectfully submit that the prior art multiple crystal growth rate and results disclosed in Kitaoka have already essentially been disclosed by

Example 3 in the original specification (again, see Example 3 results on page 8, lines 9-14 of the specification). Accordingly, Applicants respectfully submit that the disclosure of Kitaoka is merely consistent with the results of Example 3, which again provides evidence of the criticality and importance of both the pressure and temperature ranges now recited in pending claim 1. As such, Applicants respectfully submit that it is clear that there is no disclosure or suggestion in Kitaoka, as in Sasaki, in any manner or form, on how to grow a single GaN single crystal by the specific use of the now claimed pressure and temperature ranges of the present invention to provide a single gallium nitride single crystal growth rate of at least 25 μm/hr, as in the presently claimed invention. Accordingly, Applicants respectfully request the reconsideration and withdrawal of all above grounds of rejection based on the applied references.

5. Claims 8-9 were rejected under §103(a) over Sarayama in view of Sasaki; claim 10 was rejected under §103(a) over Sarayama in view of Sasaki and further in view of D'Evelyn; and claim 12 was rejected under §103(a) over Sarayama in view of Sasaki and further in view of Kitaoka. The rejections of claims 8-10 and 12 are noted, but deemed moot in view of the cancellation of these claims.

New dependent claim 13, which depends from claim 5, has been added to further emphasize the distinctions of the present invention over the applied prior art of record. New dependent claim 13 further recites that the crucible is driven downward

after a predetermined amount of time to separate the seed crystal from contact with the flux (which inherently cools the grown crystal).

Applicants respectfully submit that the group III nitride crystal growth method of Sarayama discloses that the temperature in the reaction vessel temperature is first reduced, cooled and stabilized to 300°C prior to the mixed molten liquid holding container and/or support being vertically moved or lowered. Accordingly, Applicants respectfully submit that claim 13 provides even further patentable distinctions over the applied prior art of record.

New claim 14 was added to emphasize that the present invention grows a single crystal having the same lateral dimension as the underlying seed crystal. This further distinguishes the multiple single crystal growth technique of Kitaoka.

For at least the foregoing reasons, Applicants respectfully submit that all claims pending herein are now in condition for allowance. Accordingly, the Examiner is requested to issue a Notice of Allowance for this application in due course.

If the Examiner believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, the Examiner is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

Respectfully submitted,

October 22, 2010
Date

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